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Distributing data processing: A methodology for developing an appropriate organizational DDP model.

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DISTRIBUTING DATA PROCESSING: A METHODOLOGY FOR DEVELOPING AN APPROPRIATE ORGANIZATIONAL DDP MODEL

by

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ABSTRACT

Distributed data processing possesses a wide variety of definitions. Underneath the definitions exists a basic objective - moving computer resources closer to the people who use them. The means for achieving this task is where the general controversy begins.

Some analysts believe a "true" distibuted data processing system incorporates independently linked minicomputers each having equal authority and autonomy in a loosely controlled network. Others advocate strict hierarchical rules where a mainframe takes control at the helm. And many experts place their position somewhere between these two poles.

All are right and none are right. The definition of DDP is as flexible as its design. The original objective, however, putting computer resources closer to the people who use them, remains universally shared.

Most people knowledgable in MIS believe distributed data processing (or DDP) is a good applicable concept, the natural evolutionary step in MIS/DP technology. Yet, a far fewer number believe DDP is readily implementable. The reasons: lack of a methodical rigorous approach for determining if such a system should be installed (and/or the current system should be converted), how it should be

designed, implemented and maintained, who should be responsible for which activities and the resulting cost savings and benefit realizations.

This thesis illuminates resolutions to this problem.

1. INTRODUCTION

1.1 Background Information

1.1.1 DDP - A Brief Overview

> Popular usage has attached the name 'distributed processing' to any approach that employs more than one processor to solve a computing problem.[1]
>
> DDP is the systematic decentralization of data processing activities - including a wide range of technical tasks and management responsibilities, it offers an organization the opportunity to develop and operate computerized information systems that both match the organizational structure and promote organizational goals.[2]

Distributed data processing, a way to decentralize computing hardware/software and corresponding data processing activities throughout an organization, has greatly increased its credibility within and across the corporate world. Due to the advent of data communications technology, the rapid development of

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[1] Burt H. Liebowitz, "The Dimensions of Distributed Processing," COMPUTERWORLD EXTRA, 14, No. 38 17 Sept. 1980, p. 85.

[2] Jack R. Buchanan and Richard G. Linowes, "Making distributed data processing work," HARVARD BUSINESS REVIEW, 58 No. 5 (September-October, 1980), p. 144.

sophisticated minicomputer and microcomputer equipment and the continued reduction in hardware costs, the decision of whether or not to go "DDP" is being felt at all organizational levels.

Numerous articles have been written about DDP; its extreme proponents claim that it is the only way to go while the more traditional camp cautions of its pitfalls. Naturally, the concept of distributed data processing, still in its formulation period, has acquired a range of definitions reflecting a diversity of opinions.

The first definition above is extremely general. It illuminates the concept that two or more processors are sharing data processing tasks. This definition is good because it is simple, comprehensible and encompassing. It should be embellished upon however, by emphasizing that the one or more processors can be either intelligent terminals or whole computers and that in solving this computing problem, the processors communicate to one another via a local network or over long-distance telephone lines.

The second definition, the words of a strong DDP advocate, emphasizes the positive functions and applications of DDP within an organization. This definition highlights the fact that DDP is not merely the distribution of hardware, automation and computer power, but also the distribution of personnel, programming, maintenance activites, policies and procedures, levels of responsibility, in sum the distribution of all EDP-related activities within an organization that previously were handled at a central site.

Thus, the decision to go DDP within an organization has considerable impact on that organization's internal structure. Moreover, an organization's internal structure has enormous impact on the applicability of this method, the degree to which this method should be implemented and most significantly whether or not this method is a success or failure.

> Distributed data processing is then a method that systematically decentralizes data processing and its accompanying activities via two or more communicating intelligent processors and is designed within the bounds of the organization's structure and goals.

1.1.2 Computerization: The Early Years

Computerization has gone through several evolutionary periods before reaching its current centralized - distributed transient state.

During the 1950's and early 1960's, the computer, large, cumbersome, expensive and standalone, was purchased by a company, installed in its corporate headquarters and used to automate payroll, billing and inventory functions. With the emergence of the conglomerate and the increasing expansion of large corporations, departments and subsidiaries discovered that their needs were not being met by this standalone machine. Reports, usually overdue, were obsolete before they arrived on a supervisor's desk and inaccuracies (due to keypunch errors and lack of editing) abounded.

During the late 1960's and early 1970's, the combination of pressure from management and considerable advances in data communications technology pushed the trend toward increasing centralization. As data processing gained greater corporate visibility, top management began to question the necessity of the large number of dollars being spent. Why was it necessary to have redundant accounting applications developed for different departments along with multiple data processing managers and keypunch personnel; moreover, why have a multitude of small and medium-scale computers when large ones with multiprocessing operating systems were becoming increasingly affordable?

So management tightened control and dictated the installation of the mainframe in a central computing facility. This central computer used phone lines to provide access to remote terminal clusters of limited power and versatility.

1.1.3 The Advent of Distribution

No sooner had centralization received the stamp of acceptability, when vendors began to recognize its weaknesses.

During the early-mid 1970's, strong criticisms emerged regarding the flaws of strongly centralized facilities with only limited capability at remote locations. Because so many users in the field were attempting to access the central system, large data input bottlenecks occurred along with considerable delays in the receipt of time-dependent business report data. Furthermore, the remote users feared overdependence on the central site; there was a definite need for facilities with which they could continue their work if something happened to the mainframe.

Thus, the centralization concept was insensitive to the remote users' needs; greater data processing power was needed in the field where many of the DP tasks were expected to be performed.

With the advent of minicomputer and microprocessor technology, vendors replaced the remote terminal clusters with powerful "small" processors. These processors offered multi-function capabilities such as data entry, database inquiry, word processing and program development. It was about here that DDP had its birth.

1.1.4 The Early DDP Technology and its Deficiencies

While the concept of distributing data processing power represented a breakthrough solution to the problems encountered in the centralized shop, in practice, many questions were left unanswered and numerous mistakes have been made.

For example, in order for a communications network to be successful, the hardware/software systems at the various sites must be compatible with one another. However, the early DDP networks experienced language, architecture and communications barriers. While the central processor was coded in a fairly standard language such as COBOL/VS, the remote processors were often written in some obscure language unknown by many programming staffs.

Additionally, many of the remotely installed systems offered only certain communications protocols so that communication was very inefficient.[3] Furthermore, organizations in their exuberance to grasp the seemingly state-of-the-art solution, were installing these systems in inappropriate settings. Systems were implemented in remote clerically-oriented sites where lack of DP-

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[3] IBID., p. 2.

oriented personnel resulted in little or no support, control, operation and maintenance of the system.

Hence, endorsement of DDP without careful technical analysis, placement of data processing responsibility in ill-prepared areas and the lack of an overall master plan ensured varying degrees of failure. In sum, the early enthusiasm precipitated by DDP caused the cart to come before the horse. The situation is expressed accurately by John Ferrick:

> To resolve the problems of those primitive DDP operations, designers may just have to go back and rethink the original concepts. They may have to recognize that although 'traditional DDP' had to be concerned more with the distribution of processing, now most of the technology problems have been solved.[4]

What remains to be optimized apparently are the analytical and implementation procedures associated with the proposed DDP system. The DDP system, though partitioned, must be conceptualized as a unified whole. Coordination and control between the various distributed data processing activities is of primary importance.

When DDP had its debut, the designers were

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[4] IBID., p.3

frequently so concerned with providing remote DP sites a sense of control over their systems that they neglected the corporate center.[5] Consequently, the corporate headquarters could not maintain its unifying grip; lack of control and needless conflicts followed. A successful DDP conversion thus requires a high level neutral central facility to coordinate the following functions:

Hardware evaluation and selection
Establishment of MIS standards, procedures and documentation policy
Short and long-range MIS planning
Recruiting
Information systems auditing
Maintenance of corporate database
Establishment of corporate-wide priorities[6]

1.1.5 DDP and its Applicability

Just as the analysts responsible need to step back and coordinate the procedures associated with a DDP installation, a methodology must be developed to determine if distribution is in fact applicable to an organization's DP environment at all. Cort Van

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[5] IBID., p. 2

[6] Larry E. Long, DESIGN AND STRATEGY FOR CORPORATE INFORMATION SERVICES (Englewood Cliffs, N.J., Prentice-Hall, Inc., 1982), p. 122.

Renssalaer, a systems planner with considerable DDP experience, provides some inciteful information:

> The most significant lesson we have learned from our experience is that there is no best way to process data. Information systems must be designed to match the organization they support.[7]

The main advantage of distributed data processing lies in its adaptability relative to the structure of most organizations.

While the original standalone centralized systems often forced organizations (especially divisions) to radically alter their procedures in order to obtain information, and the sophisticated highly centralized shop decreased divisional autonomy (and perhaps consequently performance), the DDP design allows an organization to mold its computer system to its physical and procedural structure.

Since most corporations experience some degree of distribution or diversification in their structure and policy, distributing data processing operations is logically a beneficial decision.

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[7] Cort Van Rensselaer, "Centralize?, Decentralize?, Distribute?" DATAMATION, April 1979, p. 90.

When Impact Marketing Systems of Ellicott City, Maryland conducted a random sample survey entitled "DDP Markets: Structure and Analysis", they discovered two major factors constraining an organization's conversion to DDP. They were:

Lack of Substantiated Cost/Benefit Data

Central and Remote-site staff limitations[8]

Organizations reluctant to dive into this "state-of-the-art" approach, those taking the conservative doubting Thomas attitude, are wise. They rightly require a quantitative analytical methodology to answer the following questions:

Is DDP applicable to this organization? Is it truly cost and benefit justifiable here?

How much and what kind of distribution should take place? What type of logical DDP design structure is applicable to this organization?

How will this logical design structure be realized? How can the organization plan development and ongoing operational activities?

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[8] "What's Holding Some Users Back from DDP?" COMPUTERWORLD SPECIAL REPORT, 28 July 1980, p. 19.

1.2 Thesis Objectives

1.2.1 General Objective

The overall objective of this thesis is to provide answers to the questions stated in Section 1.1.5 via the provision of a methodology that develops an appropriate organizational DDP model.

1.2.2 Specifics of Objective

The model will be derived via the following activities:

1. Analysis and synthesis of the organization's structural-strategic framework
2. Creation and tailoring of a logical design structure based on the structural-strategic framework
3. Planning and allocation of responsibilities for successful development/implementation of the logical design structure
4. Estimation of current and future costs and benefits

1.3 Organization of Thesis

The thesis is organized into six chapters. Chapter one provides background information, an outline of the thesis objectives and the approach toward model development. Chapter two describes various organizational structures and strategies and facilitates the conceptualization of the organization framework.

Chapter three presents methods for designing the optimal distribution of processors and data and Chapter four explains ways to distribute responsibilities during system development. Chapter five describes criteria for a cost-benefit analysis and Chapter six presents conclusions and recommendations for further study.

2. THE ORGANIZATION: CONCEPTUALIZING THE FRAMEWORK

2.1 Overview

This chapter presents methods for outlining an organization's framework.

The framework is composed of a structural base, the hierarchical and horizontal relationships between employees, and a strategic plan for short-term and long-term growth. An organization can only successfully utilize its framework, that is implement its growth strategies within its structural boundaries, if an efficient and effective communication system exists. With the advent of sophisticated data communication technologies in the 1970's, the data processing department no longer has a minor influence on a corporation. To quote James Martin, "it has become its heartbeat and data communications the arteries."[9]

So in outlining the framework of an organization in order to create an appropriate "DDP" model, one must define the structure, determine the growth strategies and map the communication relationships between and within

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[9] James Martin, DESIGN AND STRATEGY FOR DISTRIBUTED DATA PROCESSING (Englewood Cliffs, N.J., Prentice-Hall, Inc., 1981), p. 185.

departments. In addition, those responsible must be cognizant of future DDP technology trends and determine if such trends could change the organization. For example, while some markets have ended abruptly or been curtailed due to electronic technology, others have opened up for new products and services. Hence, a certain amount of flexibility must be built into the organization's framework to allow for its changing communication requirements.

This chapter is divided into four sections.

The first section details the following four major structural forms:

1. The functional organization
2. The geographic organization
3. The decentralized product-focused organization
4. The matrix organization

Included in the analysis are explanations, structure diagrams, and mappings of the telecommunications relationships. A telecommunication relationship allows two or more parties to share and exchange information with the computer and with each other. Generally, such parties are remotely located from the computer site, use phone lines for transmission and terminals and/or printers as input/output devices. Most organizations are based upon one or a combination of these structures with subtle variations dependent upon the particular individual requirements of the company.

The second section of the chapter outlines different long-range strategic alternatives which organizations generally follow to meet performance objectives. These alternatives planned to span an implementation period from two to five years are as follows:

1. Concentration
2. Vertical integration
3. Diversification

Often, an organization will not confine itself to one alternative but develop a judicious mixture of strategies to meet its optimal growth requirements.

The third section highlights the future (five-year) DDP technology trends and their corresponding impact on the corporate framework.

The last section merges the previously defined organization criteria to create organizational framework prototypes. The remaining chapters of the thesis, those devoted to constructing corresponding DDP models and plans, continually refer to these prototypes in describing the methodology.

2.2 The Organization Structure

2.2.1 The Functional Organization

The functional organization structure divides key activities according to functional specialization. Figure 2-1 illustrates a functionally organized corporation and its telecommunication relationships.

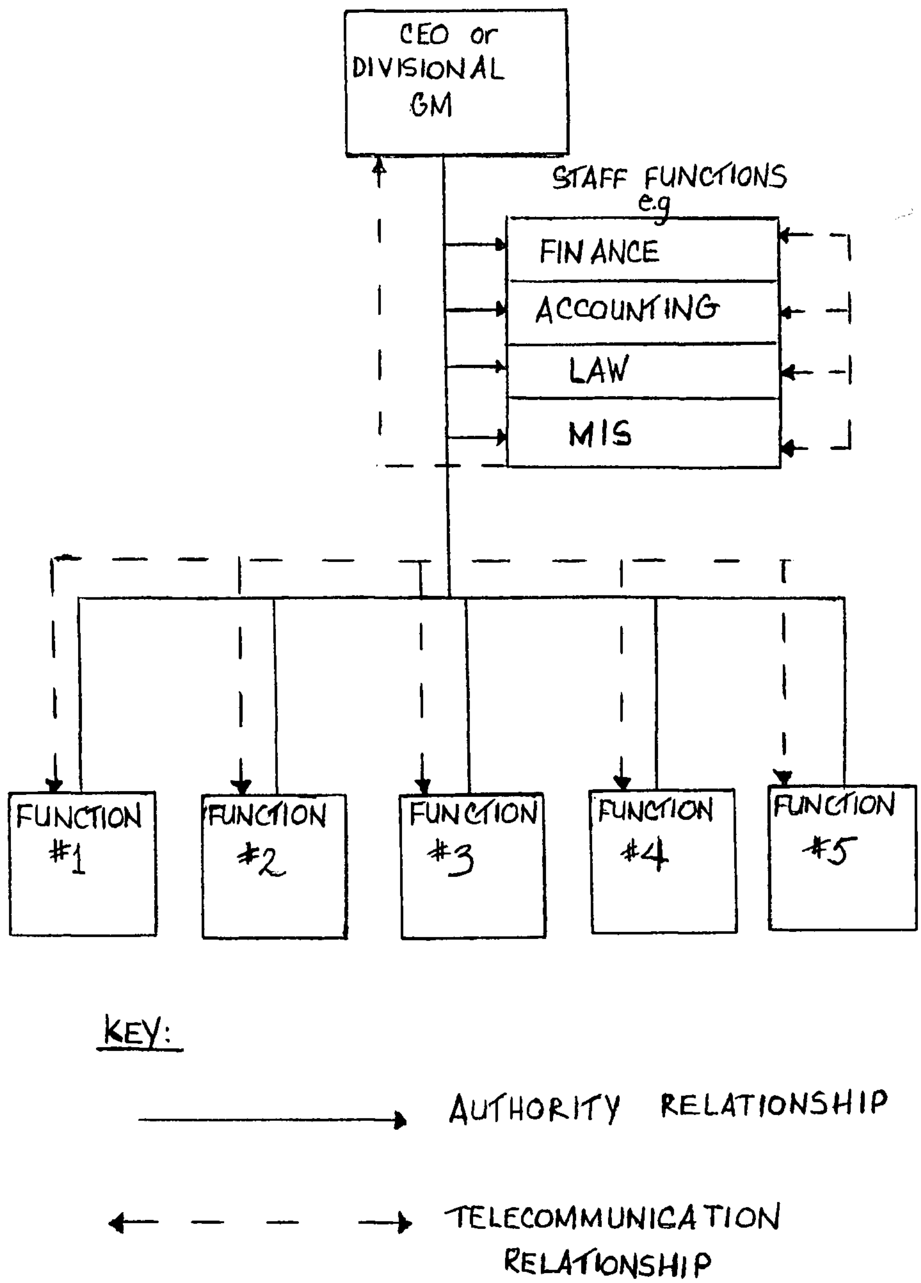
Because the functional organization derives its strengths from specialized manpower, facilities and equipment, it has the greatest potential for operating efficiency within each functional area. Moreover, the concentrated functional design promotes high emphasis on craftsmanship and professional standards as the benefits of specialization are fully exploited.

In addition, the functional organization preserves the greatest amount of centralized control; each specialized department due to its limited variety of skills cannot achieve autonomy. Consequently, there exists heavy interaction between each department and a central source, the chief executive officer or general manager.

Functionally structured organizations include:

1. Materials and technical-product manufacturing firms.
2. Municipal Governments

Figure 2-1: Functional Organization



3. Utilities

The Achilles heel of functional organizations is proper coordination and communication between the various departments. While it is not difficult to maintain communication lines within functional units (they speak the same "language" and feel a comraderie with one another), it is difficult to keep the inter-departmental communication flowing.

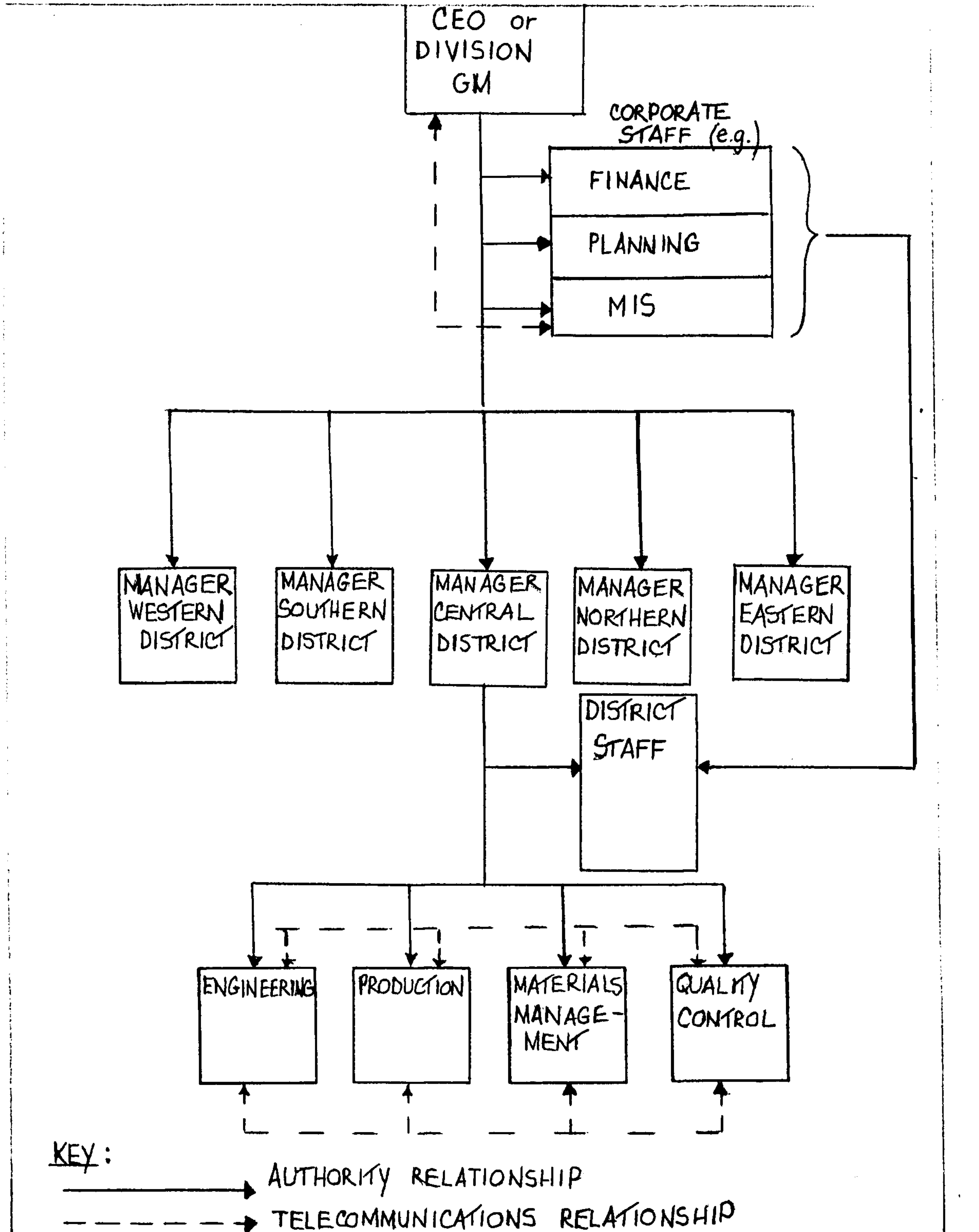
2.2.2 The Geographic Organization

Organizations whose growth and expansion has caused their operations to become physically dispersed are usually geographically structured. In this way managerial, marketing, financial and operations strategies can be tailor-made to fit the particular needs and features of each area. Figure 2-2 illustrates a geographic organization and its telecommunication relationships.

Geographic organization has taken hold in both the private and public sectors. Some examples include:

1. Chain store retailers
2. Transportation systems such as railroads and airlines
3. Banks and insurance companies
4. The Internal Revenue Service.

Figure 2-2: Geographic Organization



5 The Federal Court system

6. Religious denominations

A geographic organization is actually a group of functional organizations in dispersed locations controlled by a central headquarters at the helm. Consequently, the telecommunication relationships are quite complex and can become chaotic if not properly controlled.

2.2.3 The Decentralized Product-Focused Organization

Organizations that provide or produce various services and/or products, those that diversify readily and cater to different markets and consumer interests, generally organize along product lines.

Such product-focused orgainzations are highly decentralized; each product group acts like an independent company and thus can react quickly to sudden market shifts and product development considerations.

Because a product-focused organization does not require highly capital-intensive process technologies (where economies of scale and large production facilities are a priority), it places flexibility and innovation at a higher premium than tight control. Thus, a decentralized product-focused structure appeals to organizations having a high need and tolerance for diversity and a dominant orientation to a market or consumer group as opposed to a technology or material.[10]

Organizing on a divisional or product group basis allows top management to delegate extensive authority to a single executive. This executive becomes in effect the divisional chief executive officer and is responsible for implementing both short-term and long-range corporate strategies. Figure 2-3 illustrates a decentralized product-focused organization and its telecommunication relationships.

As is seen on the diagram, the decentralized product-focused structure can become quite complex and unwieldy. Because staff functions for each product are enclosed in individual product-line structures, the corporate staff is instrumental in communicating to and coordinating different groups regarding such central issues as personnel, policies, manpower availability, special services (including MIS) and capital expenditures.

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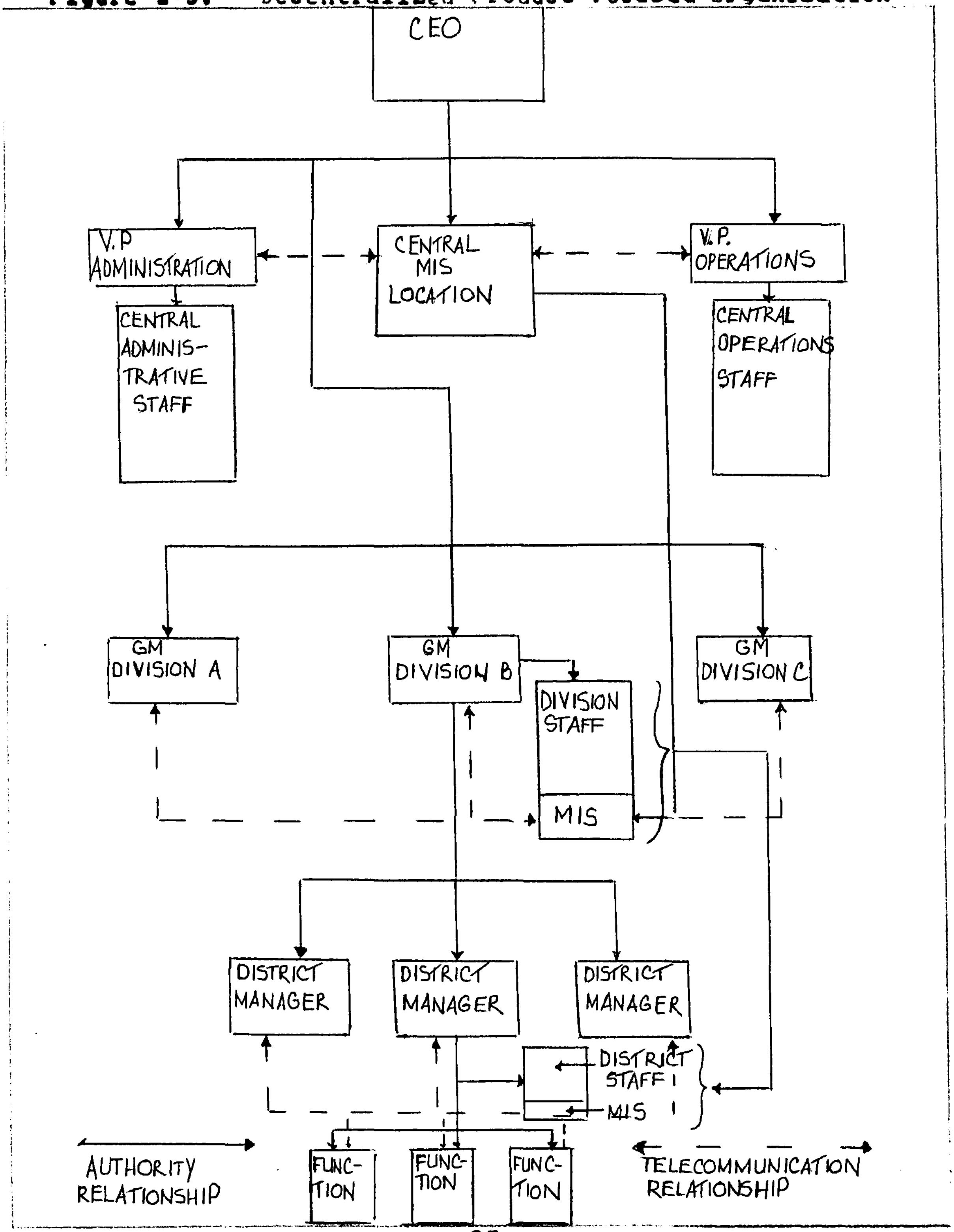
[10] Robert H. Hayes and Roger W. Schmenner, "How should you organize manufacturing?" HARVARD BUSINESS REVIEW, 56, No. 1 (January-February, 1978), 105-118.

Figure 2-3: Decentralized Product-Focused Organization



2.2.4 Matrix Forms of Organization

A matrix form of organization is a structure with two (or more) channels of command. In a matrix organization, product and functional lines of authority are overlaid to form a matrix or grid and managerial authority over employees working in each unit/cell of the matrix is shared between the product manager and the functional manager.

The matrix organization and corresonding communication relationships are incorporated into Figures 2-1 through 2-3 where applicable.

The matrix structure for many organizations has proven the most appropriate as it facilitates the greatest integration of various areas of expertise during the implementation of long-range strategic plans.

2.3 Organization Strategies

2.3.1 Concentration on a Single Business

Concentration on a single business allows an organization to utilize the efforts and resources of the total organization in catering to a clearly identified target clientele. This strategy is the simplest to implement because objectives can be made precise and results appraised easily.

Utilizing a concentration strategy, top management can develop first-hand, in-depth knowledge of the business, the market, the organization, its customers, its technology and major competitors.

2.3.2 Vertical Integration

Vertical integration takes two forms: backward integration and forward integration.

Backward integration involves the absorbtion (generally through acquisition) of the supplier or suppliers. This strategy is chosen when an organization does not have the resources to realize scale economies and performance potentials. Backward integration is frequently the most practical way to ensure sources of supply and corresponding commitment from suppliers.

Forward integration occurs when a supplier buys out a customer or group of customers. This type of strategy is chosen when a supplier experiences undependable sales and distribution channels that give rise to costly inventory pileups and frequent production shutdowns. A manufacturer, for example, may decide to integrate forward by building a chain of closely supervised building franchises or retail outlets. Such a strategy ensures greater control over the customer base and market to which the organization is catering.

2.3.3 Corporate Diversification Strategies

Diversification into new product lines is a common strategy employed by many organizations. The primary diversification strategies are:

1. Concentric diversification
2. Conglomerate diversification

Concentric diversification is related diversification. An organization will expand into areas that share common technology, customer usage, distribution channels, methods of operation, managerial knowhow or product similarity with its current product lines.

Conglomerate diversification is unrelated diversification. Large organizations with substantial financial leverage use this strategy to become larger while avoiding monopoly. Other organizations use it to escape a declining area or overdependence on a single market area.

2.4 Technology Trends: Where Data Processing is Headed

2.4.1 Hardware

> The price/performance ratio on all computers will drop greatly throughout the next ten years, but it will drop much more rapidly on tiny mass-produced machines than on machines costing hundreds of thousands of dollars.[11]

The above statement is excerpted from James Martin's DESIGN AND STRATEGY FOR DISTRIBUTED DATA PROCESSING. He predicts the continued, explosive, technological development of the minicomputer and especially microprocessor segment due to the use of VLSI (very-large-scale-integration) circuits "which can be mass produced like newsprint."[12]

In addition, with the advent of increasingly powerful minicomputers, the teleprocessing function is experiencing evolutionary changes. As processing power moves to the remote sites, TP will be used more and more to access data rather than power. Thus, the location and design of data are particularly important in distributed systems (to be discussed in Chapter three).

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[11] James Martin, OP. CIT., p. 6.

[12] IBID., p. 6.

So what about the large machines? Will their advantages grow obsolete with the onslaught of the minicomputer and microprocessor revolution? Apparently not, implies James Martin. Large computers should be fully integrated into the DDP network because they can provide elaborate instruction sets, ample memory, powerful software and data-base management. Generally acting as central coordinating hosts in a DDP network, large machines will become the vital controlling node in distributed data-base networks (a technology still in its infancy).

Thus, as small machines increase in versatility and power over the next decade and large machines increase their economies-of-scale processing, the systems designer's task multiplies in complexity. Independent of earlier processing constraints, he/she must decide what distribution of machines will best serve the corporation, what links between them are optimal and where the data will reside.

2.4.2 Data-base Management Systems: Current and Future

> One of the most difficult tricks that we have to learn is how to introduce automation without introducting rigidity. The computer industry is only now beginning to glimpse how that can be done. Data-base techniques are an important

part of the answer.[13]

Data-base management software, a highly complex technology developed in response to this demand for flexibility, is currently designed to exist in a single computer or centralized computer complex. An application-independent repository of interrelated data, the central DBMS provides each local and remote user a unique view of the data's relationships corresponding to specified needs. In a distributed data-base system, the data are stored in various physical locations throughout the network that are transparent to the user.

Distributed data-base technology is the future of software development. The software and hardware product lines of major manufacturers are likely to evolve so that they can support the various forms of distributed data bases.

Consequently, a major task for most corporations over the next ten years is to determine what data bases are needed, where they are best located, what data should be stored in them and how they should be organized. This task becomes the seed for other larger-scale

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13 IBID., p. 311.

organizational questions, such as who will be responsible for the different data bases, what kind of personnel will be required and where will they work, and how should the organization change to accomodate the technology that is accomodating and stimulating its growth?

So, as data bases become the foundation stone of corporate data processing, their dynamism will stimulate an organizatonal dynamism that will require a period of reckoning.

2.4.3 The Office of the Future

Finally "office of the future" behaviors and technologies must be considered in predicting future impacting DP technological trends. The term sometimes referred synonomously to "the paperless office" involves such technologies as work-queue management, ready information retrieval, word-processing including speech-input word-processing and electronic mail.

Work-queue management allows an executive to obtain an automated in-basket. Paperwork to be done is entered into the system and organized into queues by pre-determined types of criteria (e.g. priority). Additionally, items can be placed on the work queues of subordinates followed by automated follow-up to see which tasks have been completed.

Information retrieval facilitates access to various types of information such as the corporate data base, external informtion sources and long-range management information provided by a corporate information center.

Speech-input word-processing is still likely at least a decade away but when implemented will allow professionals to input their own documents by voice.

Electronic mail is one of the most important labor and time-saving aspects of future office technologies. Cheap fast message networks provide the possibility of holding electronic meetings with participants scattered throughout the world in homes and offices.

A completely paperless office, however, is undesirable in most organizations. The objectives are not to do away with paper but to increase productivity. Hard copy documents and reports are needed for permanence, leisurely study and scrutiny. The contents of a screen should be printed for time-independent activities and evaluation.

It is important that DDP designers be fully cognizant of "office of the future" technologies. Such technologies will change the physical structure of the office and the facilities design of the plant because executives and secretaries may choose to do an increasing amount of their work at home. Moreover, proper security controls must be necessarily built into the DDP network to accomodate home and home-bound workers.

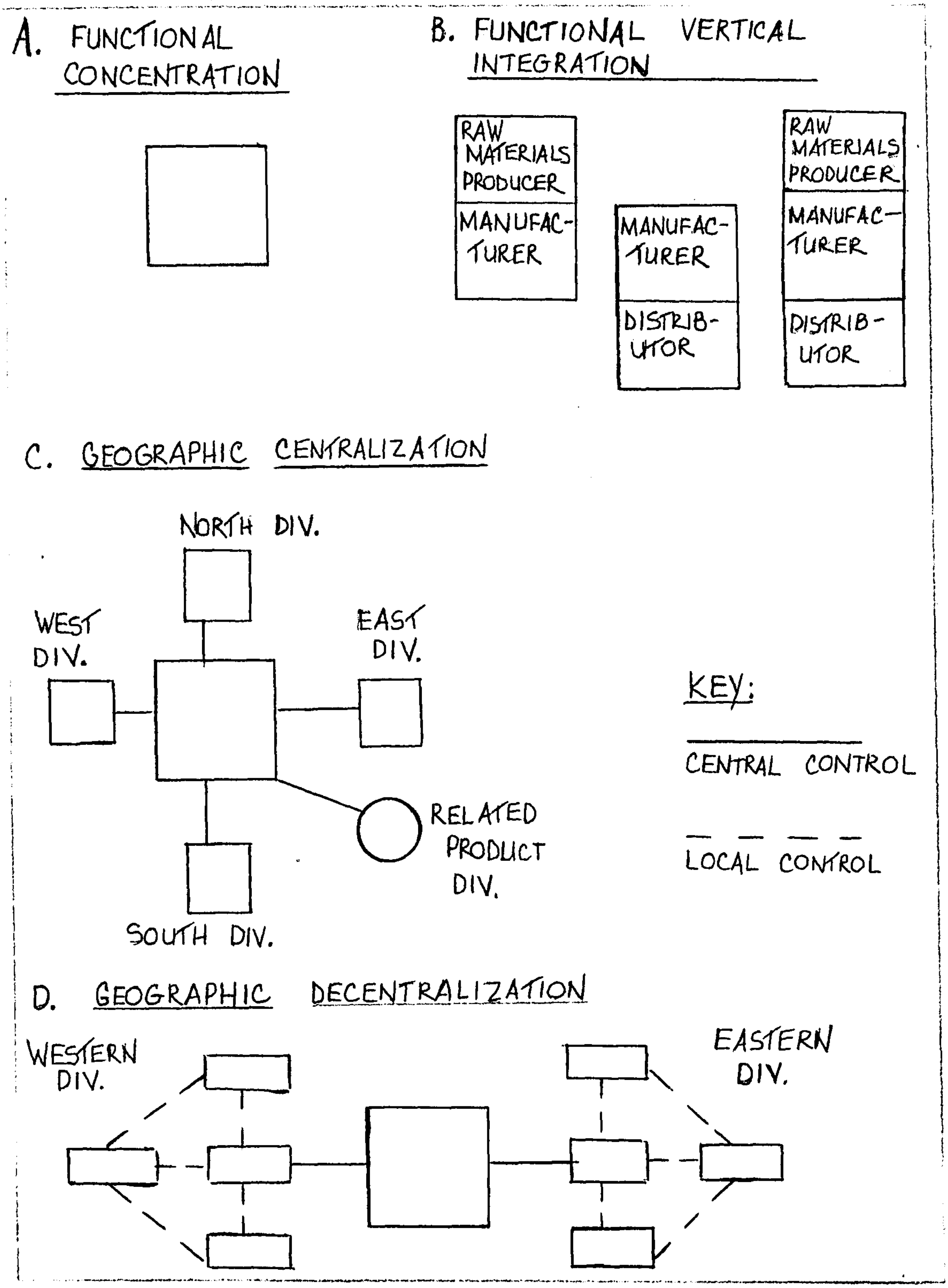
2.5 The Structural-Strategic Outline

This section derives six structural-strategic organizational forms from the previously described criteria. While, it is impossible to model every organization exclusively along these lines, the forms can serve as archetypes for similar organizations when developing a DDP model. The six structural strategic forms include:

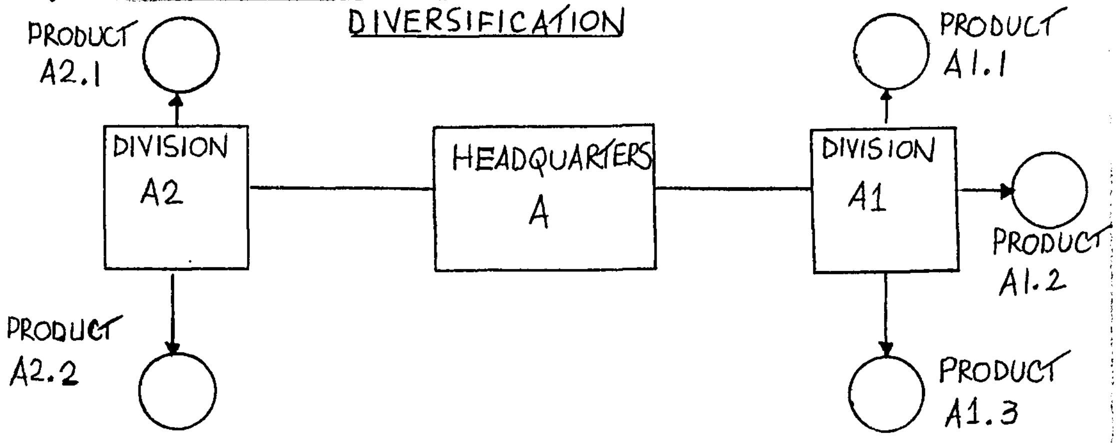
1. Functional concentration
2. Functional vertical integration
3. Geographic centralization
4. Geographic decentralization
5. Decentralized product-focused concentric diversification
6. Decentralized product-focused conglomerate diversification

These forms are described in the following subsections and diagrammed in Figure 2-4.

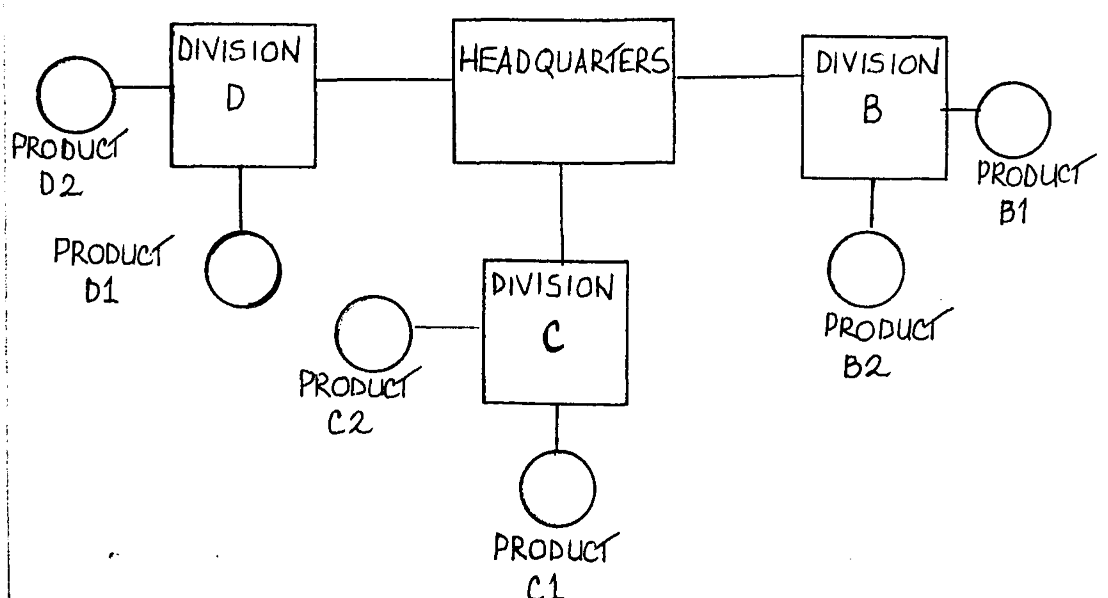
Figure 2-4: Organization Strategies



E. DECENTRALIZED PRODUCT-FOCUSED CONCENTRIC DIVERSIFICATION



F. DECENTRALIZED PRODUCT-FOCUSED CONGLOMERATE DIVERSIFICATION



2.5.1 Functional Concentration

Functional concentration describes the structural-strategic outline of insular strongly centralized organizations that have attempted to corner a niche of the market and exploit a single product, single market or single technology.

Functionally organized and contained, this organizational strategy is the most stable, conservative and steady in growth. Representing anything between a one-person business and a solid manufacturing corporation employing as many as five-hundred people, a functionally concentrated firm grows mainly through reputation, expansion within the line and specialized marketing techniques rather than via aggressive dynamic expansion strategies.

2.5.2 Functional Vertical Integration

Functional vertical integration describes a common structural-strategic outline of financially strong and established materials manufacturers, utility companies and retail organizations that cater to a large percentage of a particular market.

Such organizations are conservative, highly centralized, powerful competitors. Unlike many functionally concentrated organizations, these firms are medium to large, established in the community (older, less entrepreneurial and optimistic in spirit) and politically powerful.

2.5.3 Geographic Centralization

Geographically centralized firms maintain physically dispersed geographic divisions within t'.e confines of a strongly centralized policy and reporting structure. Generally, evolutionary outgrowths of functional concentration, such firms do not readily diversify, but are dominant in their area of market expertise.

2.5.4 Geographic Decentralization

Geographically decentralized organizations consist of a network of semi-autonomous divisions that share in the exploiting of a single market or technology in diverse geographical areas. Strategic decisions within divisions are delegated to the divisions while long-range strategic policies are determined at the helm.

2.5.5 Decentralized Product-Focused Concentric Diversification

Decentralized, product-focused, concentrically diversified organizations expand divisionally but maintain a centralized focus on product development. The divisions retain a high degree of autonomy concerning their own strategies for product/market expansion but follow a general central dictum concerning expansion outside the product line.

2.5.6 Decentralized Product-Focused Conglomerate Diversification

Decentralized, product-focused, conglomerate diversification is the most complex structural-strategic form. It consists of a central headquarters and subsidiary autonomous units which produce unrelated products. The chain of command, highly decentralized, makes general corporate control a complex, intricate task.

3. THE DDP MODELS

> In general there are three aspects of data processing that may or may not be distributed: processing, data and control. The arguments relating to the three are different.[14]

This chapter discusses the various processing and data distribution criteria and then derives logical models to match the structural-strategic oulines described in Chapter two.

3.1 Distribution of Processors

Distribution of processing can be designed around three major forms. They are:

1. Function distribution
2. Hierarchical distribution
3. Horizontal distribution

Function distribution scatters intelligence (e.g. intelligent terminals, microprocessors, controllers) in order to execute functions (rather than the complete processing) of a whole transaction.

Hierarchical distribution disperses peripheral

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[14] IBID., p. 98

processors that are capable of maintaining data and processing independence but are connected to higher level systems.

Horizontal distribution utilizes remote processors which perform the complete processing of a transaction (however, these processors can also be used for function distribution and hierarchical distribution depending on the particular application/system requirements).

Most DDP systems combine the above processing choices in a unique hybrid arrangement to conform to the requirements of the organization. This section details these three types of processing distribution and facilitates the construction of an optimal processing mixture.

3.1.1 Function Distribution

Function distribution implies a vertical distribution of function where intelligent terminals or controllers perform functions subservient to a higher-level distant computer system. Function transactions performed at these intelligent terminal nodes must be transmitted to the higher-level computer system (or network of higher-level computer systems) in order for the complete transaction to take place.

Reasons for selecting function distribution involve benefits to both the user and the system as a whole. Reasons associated with the user include:

1. Easy human-oriented interactive dialogue -
   Much of the dialogue interaction can take place locally rather than via transmission; as a result it can be designed independently of transmission constraints.

2. Fast response times -
   Local controllers can read instruments (e.g. the use of a plastic card or light pen), human actions and dialogue responses rapidly.

3. Sign-on -
   Complicated procedures for signing onto networks and remote machines can be designed to appear as simple dialogues.

4. Attractive output -
   Output received at terminals can be edited and layed out attractively for printers and screen displays.

Reasons for function distribution associated with the system include:

1. Reduction in telecommunication costs -
   Function distribution implies less transmission activity because many activities normally transmitted through the network can take place at the local terminal.

2. Less load on host -
   The parallel operation of intelligent controllers relieves the host computer of much of its workload.

3. Reliability and integrity -
   Functional processors can concentrate upon data validation and control procedures because they are not burdened with processing of whole transactions.

4. Handling peaks and transaction buffering - When short-term overloading occurs, transactions can be temporarily stored at peripheral locations until the system can handle them.

Function distribution is generally employed by fully centralized data-base management systems. An airline reservation system or supermarket transaction system where up to the minute data updates are required would benefit from such a configuration.

3.1.2 Hierarchical Distribution

Hierarchical distribution, the structuring of peripheral processors powerful enough to be self-sufficient but connected to higher-level systems, is often an outgrowth of function distribution. In other instances, the peripheral machines were originally standalone but later became linked into the hierarchical system. And of course, hierarchical systems can be designed from inception.

Hierarichal distribution is most applicable in areas where commercial applications are routinely utilized. Small, inexpensive, mass-produced processors can handle whole commercial transactions with greater speed and ease than a large machine (due to smaller software path length e.g. the number of software instructions executed for a transaction would be considerably less). The large machine could then use the result data from the commercial applications to compile longer-range management-oriented information.

3.1.3 Horizontal Distribution

When interconnected remote processors each perform complete transaction processing and no subsystem is subordinate to another, a horizontally distributed framework has been achieved.

Horizontally distributed systems are generally much more complex than functionally and hierarchically distributed systems and often encompass characteristics of both. For example, a typical horizontally distributed network might involve horizontal communication between the top units in each subsidiary of a conglomerate; however, each of these subsidiaries may have unique functional and/or hierarchical systems running their internal organizations.

Horizontal configurations are often classified according to their degree of homogeneity, that is the degree of similarity between the different communicating nodes or systems. Homogeneity is based on three factors. They are:

1. Similarity of machines

2. Similarity of applications

3. Similarity of organizations served

Systems that maintain a medium to high degree of homogeneity are called cooperating networks. The banking and airlines industries use such networks, the former for rapid electronic funds transfer, the latter for national and international booking of reservations. Networks that do not possess any homogeneity are called "non-cooperative" systems. The ARPA network or ARPANET, a system developed by the Advanced Research Projects Agency of the U.S. Department of Defense is such a non-cooperative example. It interconnects a wide variety of incompatible computer systems in many different universities and research organizations.[15]

3.2 Distribution of Data

The decision regarding location of data in a distributed processing system is a complex and strategically sensitive task. This section illuminates the criteria that should be considered during this decision process.

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[15] IBID., p. 132.

3.2.1 Centralization of Data

The decision to centralize data is based on the degree of software complexity and transmission requirements.

Applications that require a complex instruction set are stored and run with least expense on large computers. Conversely, applications requiring a simple instruction set benefit cost-wise utilizing small systems.

Concerning transmission costs, one must ask the question, where is the transmission taking place? In North America, for example, transmission is relatively cheap and efficient. In some European countries however, transmission costs are as much as ten times more expensive and are continually rising due to policies of government telephone administrations.

Additionally, certain types of data contain inherent characteristics that make centralization the better strategic choice. Such characteristics include:

1. Data-base management usage - As of this writing data-base systems still require the use of large powerful computers and corresponding centralized or multi-centered data. In the future, as minicomputers grow in power and flexibility, data-base operations will be distributed to lower-cost machines and end-user locations.

2. Time-dependent data requirements - When users in many different areas

require access to the same current up-to-the-minute version of data, centralization avoids the problems associated with simultaneous update synchronization of multiple copies of data.

3. Information system searching requirements - When data is part of a large information system, they must be searched to provide answers to spontaneous queries from users. If information system data are geographically scattered, the search can be extremely time-consuming.

4. High-security data - Data that require a high level of security are better protected in one location with external backup copies than if they are geographically scattered.

Centralized data can be stored in one processor or in multiple processors. This decision depends on the hardware storage capacities chosen and degree of complication involved in the software.

3.2.2 Decentralization of Data

Where technology costs permit, it makes sense to store data where they are most frequently used. It has been revealed repeatedly that when user departments consider their data "our data" and retain responsibility over it, the data's integrity improves and the accuracy is considerably higher.

Decentralized data can be designed dependently hierarchical, independently hierarchical, or horizontal in structure.

A dependent hierarchical system encompasses data in low-level machines that is closely related to data in a higher-level machine. Often the data in the low-level machines are subsets of the data above. The master copy kept in the higher-level machine receives changes from the low-level machines either immediately or later in a batch updating cycle. cycle.

A dependent hierarchical system may also involve various levels of storage. The lower-level machines might, for example, store bulky customer demographic information. The higher-level machine reserves its space for details of sales so that management reports can be created.

Independent hierarchical data systems involve the interaction of self-sufficient processors where the high-level machine is an information system, e.g. designed to answer spontaneous queries from management and planners. The lower-level machines and data perform functional routine operations such as production control, accounting and inventory control.

Horizontally distributed data systems whose data maintain equal status in dispersed areas may be split geographically, separated functionally, heterogenously dispersed, and/or replicated to avoid high transmission costs.

Split data incorporate similar or identical applications and data structures in different locations. For example, customer magazine subscription records, though identical in form, should logically reside in their different geographical areas.

Separate functional data involve different data structures in various locations forming an integrated system. A corporation often performs payroll in a separate location than production; distributing the data in a separate functional manner would be applicable here.

A heterogeneous data system might consist of any combination of split and separate data systems. It is a broad-scale system used to link large independent organizations such as a Stock Market system, a University computer, a Newspaper Information system and a Financial Forecasting service. Sometimes a distributed network is designed to store multiple copies of the same data in different locations. This occurs when expensive transmission costs prohibit the use of a centralized data base.

As with processing distribution, an organization will frequently need to design a judicious mixture of the different data distribution methods described to blend the DDP system into the needs of the organization. And in many DDP installations, the distribution of processors is not considered until the distribution of data has been mapped.

The next section provides the methodology for deriving the applicable model mixture; it is here that the inherent versatility found in DDP is particularly illuminating.

3.3 Derivation of Models

Figure 3-1 consolidates in grid form the design criteria described thus far. As indicated on the key, an "FC" in the Data-Processing characteristic cell indicates that the combined criteria is most applicable to a functionally concentrated organization. A "VI" indicates applicability to a vertically integrated company and so forth.

The overlapping of different organization frameworks in shared Data-Processing cells reveals the fundamental flexibility of DDP. There is no singular and rigid DDP model for an organization. Rather, the organization selects the mixture of DDP options that most suitably fits its needs.

If DDP's main advantage lies in its ability to adapt to the structural-strategic framework of an organization, how does this mapping take place? A top-down, then bottom-up modular approach is recommended.

Figure 3-1: Organization DDP Design Criteria

DATA CHARACTERISTICS

PROCESSING CHARACTERISTICS

	CENTRALIZED DATA	DEPENDENT HIERARCHICAL DATA	INDEPENDENT HIERARCHICAL DATA	SPLIT GEOGRAPHICAL DATA	SEPARATE FUNCTIONAL DATA	HETERO-GENEOUS DATA
TOTAL CENTRALIZATION	FC					
FUNCTIONAL PROCESSING	FC VI	FC VI GC				
HIERARCHICAL PROCESSING	FC VI GC	VI GC	GC GD CONC. D	GC GD	VI GC GD	VI GC GD CONC D
HORIZONTAL PROCESSING			GD CONC D	GD CONC D CONG D	GD CONC D CONG D	GD CONC D CONG D

KEY

FC = FUNCTIONAL CONCENTRATION
VI = VERTICAL INTEGRATION
GC = GEOGRAPHIC CENTRALIZATION
GD = GEOGRAPHIC DECENTRALIZATION
CONC D = CONCENTRIC DIVERSIFICATION
CONG D = CONGLOMERATE DIVERSIFICATION

A top-down functional organization is an organization in its fundamental form. Functional organizations cannot be further decomposed into more tightly-bound compositional structures. They can only be further divided by function. As organizations increase in size and scope, they become cluster-like, loosly-bound combinations. A top-down geographic organization is composed of similarly organized functional modules in different geographical areas. A top-down decentralized product-focused organization is composed of clusters of geographical organizations which are in turn broken down into functional structures.

In looking at the organization top-down, the analyst first decides on the overall DDP approach to employ.

An organization that is purely functional will employ a functionally organized DDP system.

An organization catering to a particular market in very distinct geographical areas will use some combination of hierarchically distributed data processing.

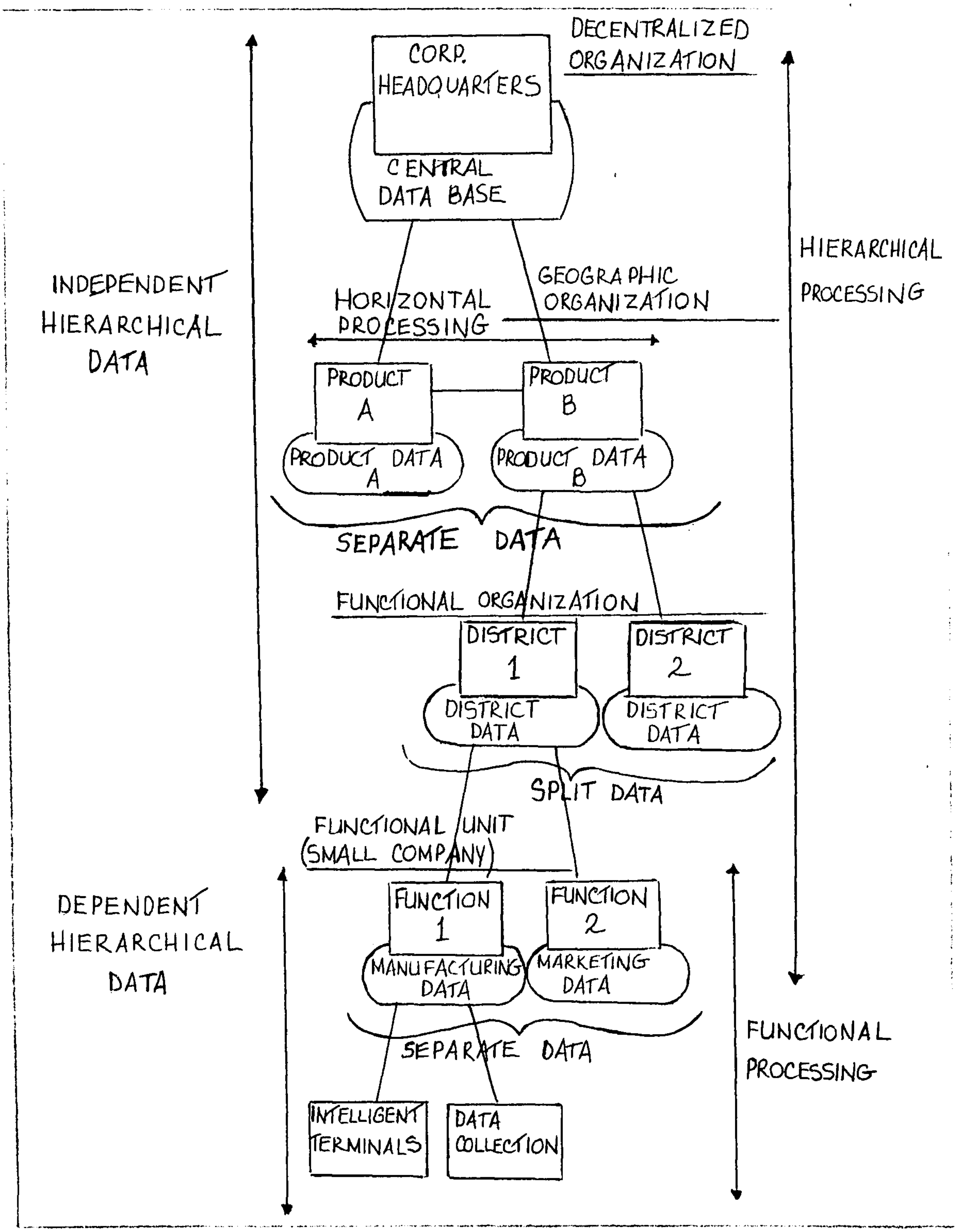
A decentralized product-focused organization will also use hierarchical DDP but the structure here will have a greater degree of hierarchy as this organization composition is more complex than the geographical organization.

Finally, an organization that is actually a group of organizations such as a multi-national conglomerate, the Federal Government or the ARPANET system will best utilize a DDP system horizontal in nature.

Bottom-up analysis involves expanding from most detailed to most general. After the analyst has narrowed in on the overall organization framework, he/she breaks it down to the various functional units. Each functional unit then becomes a separate module or sub-structure of the entire organization. It is first analyzed in terms of its data processing needs as an independent unit and then hierarchically connected to the module above it. This methodology when used in programming is referred to as the structured approach and should be applied to DDP model building as well.

Figure 3-2 utilizes the concepts discussed in Chapters two and three to arrive at a DDP model building chart for an organization. Purely functional organizations would only utilize the lower portion of the chart for mapping while organizations of greater complexity would use an increasing percentage of it. Organizations whose strategies involve geographic expansion or product-line diversification should map their DDP model along that higher goal level on the chart. This will facilitate the planning of overall MIS expansion that must accompany successful corporate growth.

Figure 3-2: Data/Processor Distribution



4. DDP DEVELOPMENT

Chapter three discussed a theoretical approach to DDP model building. This chapter provides the practical development tools for converting the theoretical model into working form.

4.1 The Responsibility Matrix: Tasks

Figure 4-1 illustrates a Development Responsibility Matrix. The vertical axis of the matrix outlines the following tasks:

4.1.1 High-Level MIS Steering Committee Establishment

The conversion from a strongly centralized MIS environment to DDP affects every member of the organization. An activity of such broad scope must be overseen by an objective high-level controlling body. This body, composed of six to eight VP-level executives from different functional and geographic areas of the organization, is called the High-Level MIS Steering Committee.

High-Level MIS Steering Committee responsibilities include:

1. Visible encouragement and support of the DDP function as a means toward an integrated cohesive organization

2. Presentation of periodic development progress reports and recommendations to the chief

Figure 4-11: Development Responsibility Matrix

P = PRIME R = PARTICIPATORY C = CONSULTING A = APPROVAL	HIGH-LEVEL CORPORATE MANAGEMENT	CENTRAL MIS GROUP	DIVISIONAL MANAGEMENT	DIVISIONAL MIS GROUP	FUNCTIONAL MANAGEMENT	END-USERS
HIGH-LEVEL MIS STEERING COMMITTEE ESTABLISHMENT	P					
DDP LONG-RANGE PLANNING		P		C		
HARDWARE/SOFTWARE SELECTION COMMITTEE ESTABLISHMENT		P		C		
CURRENT SYSTEM FLOWCHART		P		R		
SYSTEM CONSTRAINTS DEFINITION		P	R	R		
APPLICATIONS DESCRIPTIONS				P/C/A	R	R
SYSTEM REPORTS & DOCUMENTS DEFINITION	R	P/C/A	R	P/C	R	
DATA BASE CONCEPTUAL DESIGN		P		R		
PROPOSED SYSTEM FLOWCHART		P		C		
GLOSSARY OF UNIQUE TERMS		P				
ESTIMATED PERSONNEL [illegible]	A	P	R	R	R	

Figure 4-11: Development Responsibility Matrix

P = PRIME R = PARTICIPATORY C = CONSULTING A = APPROVAL	HIGH-LEVEL CORPORATE MANAGEMENT	CENTRAL MIS GROUP	DIVISIONAL MANAGEMENT	DIVISIONAL MIS GROUP	FUNCTIONAL MANAGEMENT	END-USERS
HIGH-LEVEL MIS STEERING COMMITTEE ESTABLISHMENT	P					
DDP LONG-RANGE PLANNING		P		C		
HARDWARE/SOFTWARE SELECTION COMMITTEE ESTABLISHMENT		P		C		
CURRENT SYSTEM FLOWCHART		P		R		
SYSTEM CONSTRAINTS DEFINITION		P	R	R		
APPLICATIONS DESCRIPTIONS				P/C/A	R	R
SYSTEM REPORTS & DOCUMENTS DEFINITION	R	P/C/A	R	P/C	R	
DATA BASE CONCEPTUAL DESIGN		P		R		
PROPOSED SYSTEM FLOWCHART		P		C		
GLOSSARY OF UNIQUE TERMS		P				
ESTIMATED PERSONNEL REQUIREMENTS	A	P	R	R	R	
PERSONNEL TRAINING REQUIREMENTS		P		R		
FACILITIES PLAN		P	C	R	C	
PROGRAMMING		P		R		
TECHNICAL SECURITY		P		R		
BACKUP PROCEDURE DOCUMENT		P		R		
FILE CONVERSION PARALLEL OPERATION CUTOVER	R	P	R	P	R	R

executive officer and board of directors

3. Approval or rejection of requests for major DDP services

4. Priority setting of approved DDP development projects

5. Monitoring the progress of ongoing DDP development projects

6. Setting overall DDP policies concerning relations between the central MIS department and the various distributed nodes[16]

The High-Level MIS Steering Committee should meet on a monthly basis with the MIS Director during development where the latter provides the committee a detailed progress report. The committee also meets bi-monthly with the Chief Executive Officer to provide him/her the consolidated progress report and recommendations.

4.1.2 DDP Long-Range Planning

The DDP long-range planning function encompasses planning, allocation and coordination of all DDP-related resources over a five-year horizon. In small organizations (those employing a central MIS staff of less than twenty-five employees), the MIS Director is held responsible for the planning function. In

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[16] Long, OP. CIT., pp. 84-85.

medium-sized organizations, the planning position in filled by a Senior Operations/Systems Analyst. In large organizations (those employing a central MIS staff of greater than 175 employees), a small long-range planning group should be established.

The DDP long-range plan, the backdrop of DDP activities and goals over the planning horizon, is a flexible benchmarking tool. Its allowance for modification should be dependent upon technological advances, administrative and organizational changes within the corporation. The DDP long-range planner (or MIS long-range planner), is responsible for monitoring the progress of all activities outlined in the plan ensuring that MIS is accurately reflecting the organization's goals.

The DDP long-range plan, completed before any other development activities begin, incorporates the following areas:

1. Executive Summary
2. Introduction
3. Goals
4. Current MIS Status
   (System Flowchart)
5. Planning Constraints
6. General MIS Policies

(outlined by the steering committee)

7. Planning Areas

   7.1 Data Base and Applications

   7.2 Hardware

   7.3 Systems Software

   7.4 Organization and Personnel Responsibilities

   7.5 Operation and Productivity

   7.6 Standardization of Procedures

   7.7 Office Automation

   7.8 Contingency Planning

8. Summary of Proposed Activities

9. Costs and Benefits Estimation

10. Short and Long-Range Implementation/ Maintenance Schedules (Gantt Charts)[17]

In order to compile the above information, the DDP long-range planner will work closely with divisional general management and divisional data processing managers. The remaining tasks outlined on the Development Responsibility Matrix are fully integrated into the long-range plan where applicable.

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17 Long, IBID., p. 71.

4.1.3 Hardware/Software Selection Committee Establishment

Just as a committee must be established to maintain policy and procedural standards, an objective overriding body should be created for hardware/systems software selection and consultation.

Selection of major hardware/systems software is a central MIS function (minor hardware acquisitions e.g. memory upgrade, higher-speed tape drives not affecting other operations do not require control by or consultation with the committee). The committee should be composed of the data-base administrator and five to eight senior-level analysts and programmers within the MIS department. The group should be headed by the MIS Director.

The Hardware/Software Selection Committee has the following responsibilities:

1. Selection of initial hardware configuration that optimally matches DDP organizational model created in Chapter three

2. Establishment and maintenance of standards that clearly outline procedures for divisional purchase of new equipment

3. Management of Hardware/Software Information Resource Center (a media center open to all organizational employees providing information on latest technological advancements, in-house and outside educational seminars, and company newsletter informing employees

on status of DDP development effort)

4. Selection of system software, data-base architectures, query languages, and utilities

5. Establishment and enforcement of standards for divisional and functional applications development

6. Consultation and approval regarding major hardware and software enhancements

4.1.4 Current System Flowchart

Before new system development tasks begin, the current system or systems and procedures should be reduced to their fundamental (input, processing and output) component parts via system flowcharting techniques.

The current system flowchart provides a common base of understanding at the starting point. The document should be liberally distributed to all analysts, programmers and management personnel who are actively involved in the DDP development project. The flowchart not only illuminates fundamental procedural requirements, but pinpoints current gaps and discrepencies that could be discussed and rectified before heavy DDP investment costs are made.

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5. Establishment and enforcement of standards for divisional and functional applications development

6. Consultation and approval regarding major hardware and software enhancements

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4.1.5 System Constraints Definition

The DDP system will be developed subject to various constraints. Such constraints specified early ensure that the project doesn't spread beyond realistic boundaries. Constraints involve the following areas:

1. Equipment - Is the system being designed to utilize current equipment? Are provisions being made for upgrading? Are new equipment purchases upgradable?

2. Cost - How are the development, maintenance and operational cost constraints going to affect allocation of resources?

3. Scheduling Constraints - How will the development project affect computer availability, other functional area projects and corporate financial cycles? Where must the compromising take place?

4. Procedural Constraints - Which current organizational policies and procedures are fundamental and unchangeable? How can the new automated procedures reflect these standards?

5. Software Constraints - Are there high-level requirements to use existing or pre-specified[18] software packages?

The System Constraints Definition will require continuous updating during the course of development. It

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18 Larry E. Long, DATA PROCESSING DOCUMENTATION AND PROCEDURES MANUAL (Reston, Va., Reston Publishing Company, 1979), p. 36.

is a dynamic development tool used to enclose options within a realistic boundary.

4.1.6 Applications Description

The Applications Description is a general narrative consolidation of all proposed applications that the DDP system will support. Written in non-technical terms, the document should not exceed ten typewritten pages.

4.1.7 System Reports and Documents Definition

Defining all required documents and reports for the proposed system is an ongoing function that evolves with system development.

However, current documents and reports from the present system should be compiled and re-appraised prior to development to determine their relevancy or obsolescence.

All reports and documents applicable to the new system are to be classified by number and title and packaged according to a pre-determined criteria (e.g. by department, by application, by degree of importance, etc.). The package is then continually updated with the newly requested report definitions throughout the development (and to a lesser extent maintenance) period.

Finally, after the report is approved and implemented by the MIS staff, it is conspicuously marked (both on the document definition form and on the package number-title index) that it is on-line and available.

4.1.8 Data Base Conceptual Design

The data-base development staff (data-base administrator and zero to twenty systems analysts and systems programmers depending on organization size) are responsible for the following:

1. Data-base definition and organization
   - 1.1 Understanding user requirements
   - 1.2 Establishing data availability
   - 1.3 Design of logical data-base organization
   - 1.4 Determination of physical storage requirements
   - 1.5 Physical data-base definition
   - 1.6 Simulation of data-base performance
2. Data-base security
   - 2.1 Data-base access and modification
   - 2.2. Data-base integrity
   - 2.3 Recovery capability and procedures
3. Data-base documentation
   - 3.1 Maintenance of data dictionary
   - 3.2 Description of logical and physical structures

4.1.9 Proposed System Flowchart

At this point there is enough established information to draw a proposed system flowchart. The flowchart in breaking down the proposed system requirements and procedures into logical relationships should be specific enough to illuminate alternative approaches and provide a framework for derivation of costs and benefits. At this stage of development however, it is unnecessary (and likely impossible) to detail all system components.

4.1.10 Glossary of Unique Terms

All terms and phrases unique to the DDP development project (terms that have not been frequently used or universally understood in the organization before) require documentation in a glossary. The glossary is distributed by divisional management to all users coming in frequent contact with such terms during their interaction with the system.

4.1.11 Estimated Personnel Requirements

Estimated personnel requirements must be planned for both development and maintenance activities, for the central MIS location and for each distributed area affected by the proposed system. The following responsibilities are allocated:

1. Project leadership
2. Systems Analysis
3. Programming
4. Documentation
5. Training
6. Systems Operation
7. Secretarial/Clerical Support

Depending on budgetary and organizational constraints, the management group responsible determines the number and type of temporary and/or permanent required hirings and if any type of reorganization is necessary. For example, are people to be temporarily borrowed from other departments or would this intended financial savings have a political cost too great? Estimating personnel needs requires careful considerable analysis; it is one of the most strategically sensitive areas in the development process.

4.1.12 Personnel Training Requirements

It is necessary at this point to document estimated training required for all individuals and groups involved in system development and operation. Such a document facilitates the organization of a training staff, the planning of user manuals and scheduling/time requirements for training.

4.1.13 Facilities Plan

The Facilities Plan narrows down the physical framework required to house the system. The Facilities Planner (generally an Industrial or Mechanical Engineer) works with the Hardware/Software Selection Committee to determine physical feasibility of selected hardware. Facilities should be uniquely planned at each distributed site in the network. Areas to be planned include:

1. Ample space for system, backup system, and all system components
2. Appropriate electrical and air conditioning requirements
3. Physical security system, e.g. the use of guards, locks and alarms where necessary
4. Ample work space and lighting for individuals working with input/output devices

4.1.14 Programming

After all specifications for the system have been written, the data-base schemas modeled, the hardware, software and facilities planned and selected, personnel and training requirements established, it is time to begin the programming process. As much as possible the system shoud be geared toward end-users fulfilling their own applications programming needs. Thus, while experienced programmers are responsible for the system's technical design and implementation, training staff should encourage active end-usage of the system and gear end-user education accordingly.

4.1.15 Technical Security

Technical security ensures a sabotage-resistant system. Technical security controls must be designed into the system and conform to the following specifications where possible:

1. Programs used at peripheral locations are downloaded from the host. Thus, they reside at the location where their functions are performed but are controlled and maintained centrally.

2. Control mechanisms where possible are incorporated into hardware and microcode. This helps prevent "curious" programmers from bypassing controls.

3. High-level inquiry, report generation and data manipulation languages are provided to end-users (however, such use is rigorously audited and controlled at a central location).

4. Peripheral users have access only to their data which resides at their location; data in other machines should be locked and inaccessible unless otherwise specified.

5. Searching of data is designed to take place on separate non-peripheral-user systems. Such data should be created separately from data for production runs to improve performance and facilitate autonomy of distinct functions.

6. A large central data processing center is avoided (such a center makes replacement and reconstructing of data difficult if it is lost). Either a bicentral (a split central location) or a totally decentralized

facility is preferable.

7. Each node of the DDP network is separate and as autonomous as possible, fully auditable, and appears simple to the user despite its complexity.

8. Each transmission link is secure, tightly controlled, auditable and simple in its path and pattern.

4.1.16 Backup Procedures Document

All Backup and Restart systems and procedures should be fully planned, documented and installed at each distributed location prior to cutover. The Backup Procedures Document includes the following information:

1. System Dependencies and Priorities - If one computer system goes down, what other areas of the network will be affected? Indicate high, middle, or low priority regarding impact on other organizational/network areas.

2. Location of and procedures for utilizing primary and secondary backup sites.

4.1.17 File Conversion, Parallel Operations and Cutover

All file conversion, parallel operations, and cutover procedures must be outlined for each distributed site several weeks before cutover. This outlined plan specifies detailed time frames and deadlines, MIS and user personnel tasks and responsibilities. Most importantly, the plan is written and graphically illustrated in a clear concise manner free of irrelevant narrative and technical jargon.

4.2 The Responsibility Matrix: Groups Responsible

The horizontal axis of the Development Responsibility Matrix breaks down the distribution of responsibility for the various tasks. As indicated on the key, responsibilities can assume varying degrees as follows:

1. Primary Responsibility -
   Delegated to one key individual (and in some cases one key individual per distributed site), this person is responsible for all qualitative and quantitative aspects of the task from start to completion.

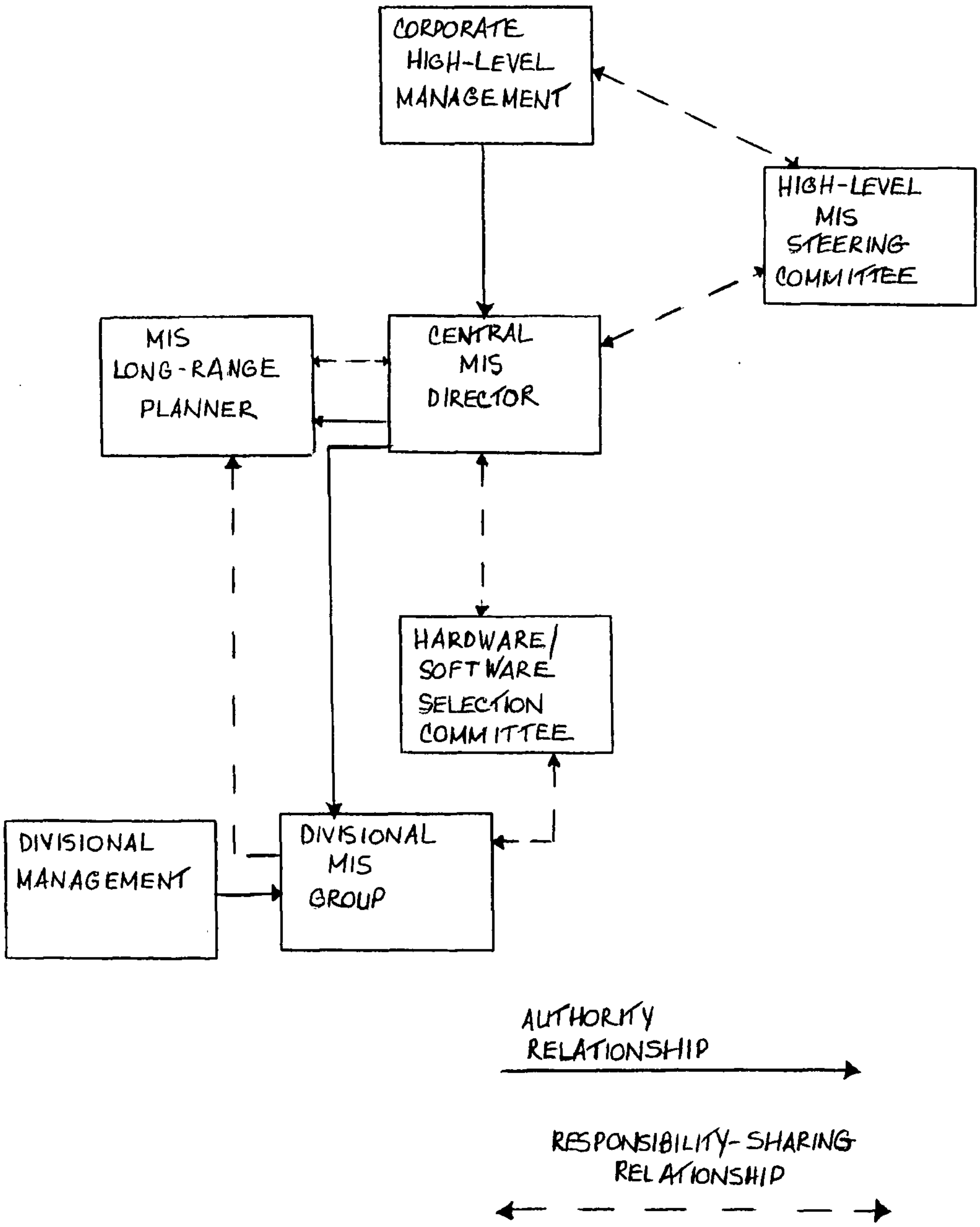
2. Participating Responsibility -
   This area can be delegated to several people at the primary person's discretion.

3. Consultation -
   While not directly involved in the task's implementation efforts, various people in the organization can provide valuable information toward a valid accurate product.

4. Approval -
   This sign-off responsibility is generally delegated to one upper-level individual to ensure administrative comprehension and control during development.

Finally, Figure 4-2 illustrates the DDP organizational infrastructure revealed in the Development Responsibility Matrix and outlined in this chapter. Both illustrations (the grid and the infrastructure chart) are

Figure 4-2: DDP Organizational Infrastructure



intended as guidelines to facilitate DDP people planning in organizations.

5. COST AND BENEFIT ANALYSIS

The DDP model has been molded to the organizational framework. A development strategy has been outlined with appropriate responsibilities allocated, facilities and security systems planned.

How much is all of this going to cost? Do its benefits justify the cost? What will be its future (five-year) costs? Will its benefits continue to span a future five-year horizon?

The answers to these questions are the deciding factors in crossing the bridge from model to reality.

While it is impossible to calculate exact projected costs of a system, there are general cost-benefit guidelines for steering analysts into the ballpark. Costs and benefits can be subdivided into two general areas. They are:

1. Physical system costs and benefits
2. People costs and benefits

Physical system costs and benefits encompass the non-human aspects of the system such as hardware, software, telecommunications equipment, physical facilities.

People costs and benefits incorporate all other aspects of the system. They are less tangible and quantifiable than physical system costs and benefits but are generally a direct consequence of them.

These areas are explained in this chapter.

5.1 Physical System Costs and Benefits

Most organizations considering the installation of a DDP system have already experienced centralized processing and are encountering the challenges of conversion rather than first-time implementation.

Distributed data processing is thus evolutionary. This evolution explained in detail in the previous chapters is realized in its resulting restructuring of costs and benefits. Distributing data processing requires a heavy initial physical systems cost investment during the development phase. Short-sighted evaluators will use this argument as a factor against DDP. However, a strongly centralized system will encounter inflexibility (and corresponding financial stress) during operation; activities dependent on the capabilities of a host will be costly.

In sum, a weight toward centralization produces development cost advantages and operations cost disadvantages. As distribution takes hold, the pattern reverses itself.

5.2 People Costs and Benefits

The physical aspects of the DDP installation impact the following people-related areas:

1. Organization
2. User perception and responsibilities
3. Salaries
4. Standards, policies and procedures

5.2.1 Organization

Organization changes will be inevitable during the DDP conversion process. As discussed in chapter four, there will be a certain amount of hiring, renting, borrowing and swapping to accomodate the system's development and maintenance. Costs associated with this reorganization process are totally dependent upon the organization's system, budgetary and political constraints.

In addition, the general character of the organization and the success or failure of past system installations are primary factors in determining the costs associated with people.

If the organization followed a conservative rigid philosophy concerning employees, e.g. keeping them thorougly entrenched in standard procedures and rules for producing output, a shift toward greater computer responsibility could be traumatic and costly. It has not been uncommon for such a shift to cause sudden mass resignations, low morale and/or reluctance to cooperate. Moreover, if past systems implementations within the organization proved chaotic, employees have every reason to be skeptical.

Thus, before development begins, it is crucial to summarize the current structural-psychological situation and develop an internal relations/training program from there. Such a program will have a cost - seminars take people away from their work; the hiring of additional training staff may be required - but this cost again is insurance against a people-DDP system disaster.

5.2.2 User Perception and Responsibilities

The DDP system brings a new role to the user. No longer a passive helpless witness to the computer's intricacies, the user must share the responsibility of proper system utilization, data integrity and general care.

This increased knowledge and responsibility will enhance the marketability of users. They may command higher salaries and/or discover new dissatisfactions with their positions as broader horizons are revealed. The cynical manager will see this as costly and unfortunate (e.g. user ignorance was blissful and cheap). The smart manager will encourage his/her transformed employees and reap considerable benefits from such personal and professional growth.

5.2.3 Salaries

Salaries, a broad cost topic should be further broken down as follows:

1. Terminal operator salaries
2. Hardware maintenance salaries
3. Software development/maintenance salaries
4. Telecommunications maintenance salaries

It has been generally established that total monies allocated to terminal operators' salaries decrease as systems gain a greater degree of distribution. The main reason: DDP facilitates increased data entry productivity. Faster response times, faster more psychologically effective dialogues, local autonomy, regular system availability, and better peak-period control procedures all provide for a higher quality of work and a smaller number of operators.

Monies allocated to hardware installation/maintenance support follow an interesting pattern in the move from centralization to full distribution. Yearly hardware maintenance is the highest for a partially distributed system (such as a functional or hierarchical system) and lowest for a fully horizontal DDP system. The reason: partially distributed hardware is technically the most complicated due to its heterogeneous mixture of equipment.

Software salary costs (salaries and fees for designers, analysts, and programmers) follow a pattern similar to that of hardware support costs. Partially distributed software and data realize the greatest costs (as opposed to fully centralized or fully distributed software and data) but usually the most substantial strategic benefits.

Telecommunication maintenance salary costs decrease with increasing distribution. Ideally in a fully distributed system, little telecommunications maintenance is required.

Thus, a partially distributed processing system is the most expensive in terms of cost. However, for most organizations, partial distribution is the optimal target. As discussed in the previous chapters, pure centralization incorporates rigidity and pure distribution encourages coordination/control problems. A short-sighted monetary cost evaluation as the criteria for implementation of one of these latter two systems will ensure considerable monetary expense later in the game.

5.2.4 Standards, Policies and Procedures

Standards, policies and procedures regarding the use of the DDP system must be carefully critically designed and rigorously enforced.

Standards must pertain to every area of the system including:

1. Selection of architecture
2. Selection of hardware/systems software
3. Data resource administration
4. Data-base administration
5. Application development
6. Programming techniques
7. System and user documentation
8. Usage decisions
9. General system use

The level of standardization rigor involved in the prior MIS installation is the primary cost determinant associated with this area. In most installations, administration of standards in the above areas will necessitate new hiring. In addition, the adjustment period associated with new rules and policies is costly. Some employees will forget the procedures. Others will attempt to circumvent them and a few may quit due to their frustration and inflexibility.

The benefits, however, associated with standards, policies and procedures are crucial. The standards are the glue that binds the loosely connected system together to form a unified whole. Without standards, the DDP system will disintegrate into a scattering of pieces. The inevitable result: a system failure with costs insurmountable.

6. CONCLUSIONS AND RECOMMEDATIONS

6.1 Conclusions

An effective successful MIS is one that supports the organization structurally and strategically.

Data processing represents the flow of necessary information to and from all organizational sources and sinks. As the means for keeping an organization alive and healthy, the function has been compared to the human heartbeat and arteries. Data processing, moreover, should become the organizational skeleton. When stripped of its high technology overcoat, the design should reveal the fundamental organization communication hierarchy - who reports to whom, where information is sent and received, how the organization optimally manages its day-to-day operations.

Finally, the MIS/data processing system should support, encourage, even stimulate ideas for organizational strategic growth.

It supports growth by providing middle management with controlling information about the internal environment and top management with planning information about the external environment.[19] It encourages growth by

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19 Robert J. Thierauf, DISTRIBUTED PROCESSING SYSTEMS (Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1978), p. 7.

speeding the flow of necessary support information throughout an organization (despite a geographic spread across state, national and/or international boundaries) and outside the corporate boundaries to and from other areas of strategic concern. It stimulates growth by revealing and presenting alternative growth possibilities that could heretofore not have been accomplished because such goals were technologically infeasible.

Distributed data processing allows this structural-strategic MIS to become reality. However, before DDP can be successfully implemented, the organization itself must be thoroughly examined, analyzed and evaluated for its exact structural-strategic framework. Then the DDP system can be designed to match this framework as appropriate levels of processing and data resources are allocated and all DDP-related responsibilities are assigned. Finally, costs and benefits are estimated from the derived DDP model to determine if the latter is in fact feasible within the organization's financial boundaries.

Upon analyzing the contents of this thesis, an organization may discover that it is not yet ripe for DDP. A strongly centralized closely contained entity with no long-range plans for expansion may find their current automated or manual system the correct structural-strategic fit.

The emphasis in the foregoing DDP model planning methodology lies in thorough objective organizational analysis as the foundation for system design.

The philosophy behind this approach is that an organization's data processing systems will hold them back or support them forward depending upon how accurately they represent that organization. Since most corporations today experience some degree of responsibility distribution and diversification, distributing data processing to a carefully carved degree, is the most accurate information flow representation.

6.2 Recommendations for Further Study

Research and development regarding the foregoing DDP planning methodology has illuminated related areas for further study. Recommended research areas might include:

1. Examination/development of technical feasibility for distributed data-base systems

   What is holding us back from true distributed data-base processing? How can it be successfully designed and implemented? Will organizations truly benefit from such an approach?

2. Examination/analysis of software tools for distributed end-users

   Are programming languages/techniques

keeping up with the DDP philosophy, e.g. its proposed ability to provide non-technical end-users easy-to-use application development languages? If these "highest level languages" are non-technically suitable, do they in fact provide the appropriate technological sophistication (necessary processing speed and application support) that end-users require?

3. Global feasibility analysis of DDP

   Is international distributed data processing feasible (e.g. worldwide networks both within the corporate private sector and the political public sector) in lieu of unstable or repressive government and political situations, varying levels of technological sophistication in different cultures and contrasting implementation costs?

There are numerous technical and administrative areas to be explored and critically evaluated regarding the usage of distributed data processing. Continual research and analysis from both a technical and managerial perspective is the key to a truly useful information system.

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